because they could stick into the worker's finger, eye, or other body parts. Those factors taken into account, when judging machinability, the alloy with the chippings in (B) is the best, and the second best is that with the chippings in (A). Those with the chippings in (C) and (D) are not good. In Table 18 to Table 33, the alloys with the chippings shown in (B), (A), (C), and (D) are indicated by the symbols "◎", "o", "Δ", and "x" respectively.

[0054] In addition, the surface condition of the cut metal surface was checked after cutting work. The results are depicted in Table 18 to Table 33. In this regard, the commonly used basis for indicating the surface roughness is the maximum roughness (Rmax). While requirements are different depending on the field of application of articles made from the brass, brass alloys with Rmax < 10 microns are generally considered excellent in machinability. The alloys with 10 microns ≤Rmax < 15 microns are judged as industrially acceptable. Brass alloys with Rmax ≥ 15 microns are taken as poor in machinability. In Table 18 through Table 33, the alloys with Rmax < 10 microns are marked "o", those with 10 microns ≤Rmax < 15 microns are indicated by "Δ", and those with Rmax ≥15 microns are indicated by "x".

[0055] As is evident from the results of the cutting tests shown in Table 18 to Table 33, the following invention alloys are all equal to the conventional lead-containing alloys Nos. 13001 to 13003 in machinability: first invention alloys Nos. 1001 to 1006, second invention alloys Nos. 2001 to 2006, third invention alloys Nos. 3003 to 3009, fourth invention alloys Nos. 4002 to 4020, fifth invention alloys Nos. 5003 to 5016, sixth invention alloys Nos. 6009 to 6045, seventh invention alloys Nos. 7018 to 7029, eighth invention alloys Nos. 8001 to 8008, ninth invention alloys Nos. 9001 to 9006, tenth invention alloys Nos. 10001 to 10008, eleventh invention alloys Nos. 11001 to 11011, and twelfth invention alloys Nos. 12001 to 12004. Especially with regard to the form of chippings, those

invention alloys compare favorably not only with conventional alloys Nos. 13004 to 13006, which have a lead content of not higher than 0.1 percent by weight, but also Nos. 13001 to 13003, which contain large quantities of lead. Also to be remarked is that twelfth invention alloys Nos. 12001 to 12004, which are obtained by heat-treating first invention alloys Nos. 1006 and 1007, are improved over the first invention alloys in machinability. It is understood that a proper heat treatment could likewise further enhance machinability of the first to eleventh invention alloys, depending upon the compositions of the alloys and other conditions.

[0056] In another series of tests, the first to twelfth invention alloys were examined in comparison with conventional alloys in hot workability and mechanical properties. For the purpose, hot compression and tensile tests were conducted in the following manner.

[0057] First, two test pieces, the first and second test pieces, in the same shape, 15 mm in outside diameter and 25 mm in length, were cut out of each extruded test piece obtained as described above. In hot compression tests, the first test piece was held for 30 minutes at 700°C, and then compressed at the compression rate of 70 percent in the axial direction to reduce the length from 25 mm to 7.5 mm. The surface condition after the compression (700°C deformability) was visually evaluated. The results are given in Table 18 to Table 33. The evaluation of deformability was made by visually checking for cracks on the side of the test piece. In Table 18 to Table 33, the test pieces with no cracks found are marked “o”, those with small cracks are indicated by “Δ”, and those with large cracks are represented by the symbol “x”.

[0058] The tensile strength, N/mm^2, and elongation, %, of the second test pieces was determined by the commonly practiced test method as will be recognized by one skilled in the art.

[0059] As the test results of the hot compression and tensile tests in Table 18 to Table 33 indicate, it was confirmed that the first to twelfth invention alloys are equal to or superior to the conventional alloys Nos. 13001 to 13004 and No. 13006 in hot workability and mechanical properties and are suitable for industrial use. The seventh invention alloys in particular have the same level of mechanical properties as the conventional alloy No. 13005, i.e. the aluminum bronze which is the most excellent in strength of the expanded copper alloys under the JIS designations, and thus clearly have a prominent high strength feature.

[0060] Furthermore, the first to six and eighth to twelfth invention alloys were put to de-zinc-ification corrosion and stress corrosion cracking tests in accordance with the test methods specified under "ISO 6509" and "JIS H 3250", respectively, to examine the corrosion resistance and resistance to stress corrosion cracking in comparison with conventional alloys.

[0061] In the de-zinc-ing corrosion test by the "ISO 6509" method, the test piece taken from each extruded test piece was imbedded laid in a phenolic resin material in such a way that the exposed test piece surface is perpendicular to the extrusion direction of the extruded test piece. The surface of the test piece was polished with emery paper No. 1200, and then ultrasonic-washed in pure water and dried. The test piece thus prepared was dipped in a 12.7 g/l aqueous solution of cupric chloride dihydrate ($CuCl_2 \cdot 2\ H_2O$) 1.0% and left standing for 24 hours at 75°C. The test piece was taken out of the aqueous solution and the maximum depth of de-zinc-ing corrosion was determined. The measurements of the maximum de-zinc-ification corrosion depth are given in Table 18 to Table 25 and Table 28 to Table 33.